by Kirk Kleinschmidt, NTØZ

Feed Line Here Is Ladder Line!

Tradition—of which ham radio abounds—is a double-edged sword. On one hand, it helps us understand who we are by way of who we were and where we came from. That's the good part. The bad part is when tradition is followed blindly simply because it's tradition. For example, some Asian cultures used to "fold" the feet of female babies back onto themselves to limit their mobility as adults or to force them to walk a certain way. It's not cool now and it really wasn't cool then, but it was traditional. Get my point?

Now, ham radio has some excellent traditions that we all respect and enjoy, but one—feed line (traditional since just after WWII, anyway)—traditionally used when, ironically, an even older, more traditional feed line is probably the better choice! Specifically, I'm talking about the prevalent misuse of coaxial cable when open-wire line or ladder line offers much better performance.

Before you run out and chop off your shiny new coax, let me explain myself. The mysteries of coaxial cable are plentiful, as are the myths and the misuses. Because coaxial cable is so handy and so readily available, and usually handles the job of getting our radio signals from the antenna to the rig (and vice versa), coax is often used improperly. Many beginners have only fuzzy ideas of how to use the stuff and only fuzzy ideas about things like impedance, velocity factors, wavelength, etc.

Even after 27 years of hamming, I'm still not fully up to snuff on the physics and the mathematics of coaxial transmission lines, but I've accumulated enough hard-won "field data" to save you a lot of headaches and get you started on the right foot. Newbies and veterans alike should really listen up, because "coaxial problems" are shared by hams everywhere. You might even have a real mess in your own backyard, especially if you're using a single wire antenna on multiple bands. Yep, coax works best for matched antennas at low frequencies with relatively short cable runs. For multiband wire antennas, especially those "tuned" by "antenna tuners," the performance can be more than dismal. In fact, your coax-fed antenna system's performance might be incredibly, unbelievably, inhumanly bad! There is a fix, however. Follow along and you'll discover how and why.

Need to work multiple bands with a single wire antenna? Then your transmission line should look like this! Ladder line, available from most amateur radio stores, usually requires an antenna tuner, but it can improve your on-air performance dramatically. This line, photographed in my backyard, measures a bit more than one inch in width.

So Much For Conventional Wisdom

The traditional multiband dipole—the beginning ham's standard antenna—is fed with a random length of 50-ohm coax that's whipped into submission by an antenna tuner. Conventional wisdom says to put up as much wire as possible and let the tuner worry about matching the load on various bands. Even on bands where the antenna's SWR is quite high, and a lot of energy is reflected back and forth between the tuner and the antenna, some RF energy will be radiated.

Gooch's Paradox, explained to me by former "Ham Discoveries" author Dave Newkirk, simply states, "RF gotta go somewhere." And indeed, it does. But it doesn't have to go anywhere in an elegant and useful fashion! In the high-SWR conditions often found in typical multiband, tuner-fed dipoles, Gooch's Paradox might as well read, "RF gotta heat the feed line!"

For example, a 66-foot dipole fed with 50 feet of high-quality, low-loss coaxial cable will tune up on all bands, 40 through 10 meters. Tuning on some bands will be touchy, but you can work stations, DX included. But how much power is being wasted because of high SWR? The manufacturer's data sheet says our cable has 1.5 dB of loss per 100 feet at 100 MHz (loss increases with cable length and frequency). We're using only 50 feet with an upper frequency limit of 30 MHz, so our losses due to SWR mismatches should be minimal, right?

Wrong. Those loss figures are for matched, resonant antennas. With high SWR values, a lot of power (sometimes most of your power) can be lost between your antenna and tuner, even with a low SWR between your rig and tuner. As we'll see, losses increase in proportion to SWR, too. A 3-dB loss represents

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a 50-percent reduction in transmitted signal strength!

On 40 meters, our 66-foot dipole is a great match, and the antenna system wastes only about 0.2 dB. Not bad! On 15 meters, an odd harmonic of 40 meters, the match is also pretty good, translating into an acceptable 0.8-dB loss. On 80 meters, however, feed line losses approach 14 dB. And on 160 meters, losses total a staggering 27 dB! If we start with a typical 100-watt output, we'll radiate about 3 watts on 80 meters and less than a half a watt on 160! No wonder your mileage may vary!

Ladder Line Is The Answer

One way to reduce the feed line losses experienced while using multiband, nonresonant antennas is to ditch our "traditional" coaxial feed line and replace it with ladder line, which, again, is even more traditional, having been the feed line of choice in ham radio's early days before the coax craze got started! As shown in the Photo, 450-ohm ladder line (parallel conductors separated by a plastic, ladder-like insulating material) replaces the coax we previously used to feed our dipole. Ladder line, also known as "450-ohm balanced line," was the norm in the days before coaxial cable (an unbalanced line). It may not be as convenient as coaxial cable, but when used with an antenna tuner designed to handle ladder line (most are), feed line losses for our 66-foot dipole stay blissfully below 0.3 dB on all bands, 40 through 10 meters! On 80 and 160 meters—big trouble spots when fed with coax—losses total 1.5 and 8.5 dB, respectively. That's a tremendous improvement!

Ladder Line Fundamentals

If ladder line were a magic cure-all, of course, we'd never use coax. For best performance, a few ladder line tips are in order. Remember the following:

• When attaching balanced feeders to houses, structures, and towers, be sure to keep the ladder line several inches away from metal (or metal-containing) objects.

• Be sure your antenna tuner has a sufficient voltage rating. Tuning antennas with high feed line SWRs can create very high RF voltages inside your tuner. Resulting arcs and sparks can damage expensive equipment (especially on bands with the highest SWRs).

• "Balanced" antennas designed specifically for ladder-line feeders usually work better than their coax-oriented counterparts. Before MFJ introduced its tuners, most hams built their own balanced tuners or looked for venerable Johnson Matchbox tuners at flea markets.

• If arcing occurs, reduce your transmitter power output or get a tuner with beefy components. Using a 1-kW conventional tuner (with balanced feeder outputs) with your 100-watt transceiver isn't excessive.

• Water, ice, and snow can affect (unbalance) ladder line. Keep things clear for best results.

• If left flapping in the breeze, the soldered connection between your ladder line feeders and your dipole wires will probably fatigue and break rather quickly. Be sure to reinforce the junction with electrical tape, etc.

• Ladder line can be hard to find. If your local ham store doesn't stock it, check the ham magazines for wire and cable suppliers. Some ops, especially QRPers, sometimes use 300-ohm TV twin-lead instead of 450-ohm line. It's a true balanced line, but reduced feeder spacing and lower-capacity insulation doesn't always produce acceptable results.

The Deluxe Beginner's Antenna

If you're suffering from antenna restrictions of any type, a balanced feed line can provide an excellent compromise between convenience and cost. Simply install the longest center-fed dipole that's practical (make each side the same length) and feed it with enough ladder line to comfortably reach your station. And don't worry about feed line length. Some hams use 300-foot runs of 450-ohm line and laugh at the losses (which, when installed correctly, are barely measurable). With a decent tuner (the beefier the better), you'll put out a decent signal on a variety of bands. And when the ham on the other end of the conversation compliments you on your newfound signal strength, you can confidently say, "Feed line here is ladder line."

A great beginner's article on the subject can be found in "The Lure of the Ladder Line," by Steve Ford, WB8IMY. A PDF copy can be found at http://www2.arrl.org/tis/info/pdf/9312070.pdf.

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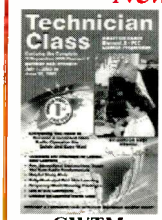

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